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PUBLIC UTILITIES
COMMISSION

The Honorable Chair and Members of the
Hawai'i Public Utilities Commission
465 South King Street
Kekuanaoa Building, Room 103
Honolulu, Hawai'i 96813

Dear Commissioners:

Subject: Adequacy of Supply
Hawaiian Electric Company, Inc.

The following information is respectfully submitted in accordance with paragraph 5.3.a of General Order No. 7, which states:

> *The generation capacity of the utility's plant, supplemented by electric power regularly available from other sources, must be sufficiently large to meet all reasonably expectable demands for service and provide a reasonable reserve for emergencies. A Statement shall be filed annually with the Commission within 30 days after the close of the year indicating the adequacy of such capacity and the method used to determine the required reserve capacity which forms the basis for future requirements in generation, transmission, and distribution plant expansion programs required under Rule 2.3h.1.*

2020 Adequacy of Supply Report Summary

- The adequacy of supply ("AOS") of Hawaiian Electric Company, Inc. ("Hawaiian Electric" or the "Company") is based on the Company's June 2019 Sales and Peak Forecast Update and other key assumptions.
- Hawaiian Electric's reserve capacity may not be sufficient to meet the Company's generating system reliability guideline of 4.5 years per day from 2022 to 2024.
- The adjusted peak load experienced on Oahu in 2019 was 1,221 MW-net and was served by Hawaiian Electric's total capability of 1,744 MW-net, including firm power purchases. This represents a reserve margin of approximately 45% over the 2019 adjusted system net peak. This reserve margin did not include the capacity of Honolulu Units 8 and 9, which were deactivated in January 2014.
- Honolulu Units 8 and 9 (with a combined rating of 107.3 MW-net) were deactivated on January 31, 2014. The 2020 AOS reference scenario reflects the Honolulu generating

units remaining deactivated, and their capacities are not included in the reserve margin calculations.

1. Peak Demand and System Capability in 2019

The adjusted peak load experienced on O'ahu in 2019 was 1,221 MW-net, and was served by Hawaiian Electric's total capability of 1,744 MW-net, including firm power purchases. This represents a reserve margin of approximately 45%[1] over the 2019 adjusted system net peak. This reserve margin did not include the capacity of Honolulu Units 8 and 9, which were deactivated in January 2014.

The system peak occurred on Thursday, October 10, 2019 at approximately 6:47 p.m., and was 1,193 MW-net based on net Hawaiian Electric generation, net purchased power generation, the peak reduction benefits of energy efficiency programs, and with several co-generators[2] operating at the time. Had these cogenerating units not been operating, the 2019 system peak would have been approximately 1,221 MW-net.

Hawaiian Electric's 2019 total generating capability of 1,744 MW-net includes 456.5 MW net of firm power purchased from (1) Kalaeloa Partners, L.P. ("KPLP"), (2) AES Hawaii, Inc. ("AES"), and (3) H-POWER.

At times during 2019, Hawaiian Electric received energy from fourteen variable generation energy producers. Since these contracts are not for firm capacity, they are not reflected in Hawaiian Electric's total firm generating capability.

2. Estimated Reserve Margins

Appendix 1 shows the forecasted reserve margin over the next five years, 2020-2024, based on Hawaiian Electric's June 2019 Sales and Peak Forecast, and includes estimated energy efficiency impacts and load management impacts. This is based on a Reference Scenario that is described in Section 5.

3. Criteria to Evaluate Hawaiian Electric's Adequacy of Supply

Hawaiian Electric's capacity planning criteria are applied to determine the adequacy of supply and whether or not there is enough generating capacity on the system. Hawaiian Electric's capacity planning criteria take into account that Hawaiian Electric must provide for its own backup

[1] The total capability value used in the calculation of this reserve margin does not account for units not available due to maintenance outages, forced outages or derates in unit capacities. The reserve margin calculation takes into account the approximately 17 MW of interruptible load that may be available at system peak. In actual real-time operations, reserves may be reduced due to maintenance, forced outages or deratings.

[2] At the time of the peak, certain units at Par Hawaii, Sheraton and Pearl Harbor were generating about 28 MW of power for use at their sites.

generation since, as an island utility, it cannot import emergency power from a neighboring utility. Hawaiian Electric's capacity planning criteria are described in Section 3.1.

The results of the annual analysis of the adequacy of supply on the Hawaiian Electric system are a function of a number of forecasts, such as:

- peak demand, including the forecasted peak reduction benefits of (a) energy efficiency from the Public Benefits Fee Administrator's ("PBFA") programs and changes to codes and standards, and (b) customer-sited-photovoltaic ("PV") with battery installations; [§4.2]
- peak reduction benefits of existing load control programs; [§4.3]
- Equivalent Demand Forced Outage Rate ("EFORd") on the generating units; [§4.4]
- planned maintenance schedules for the generating units on the system; [§4.5]
- additions of firm generating capacity; [§4.7] and
- reductions of firm generating capacity. [§4.8]

Each of the current assumptions for these and other factors is discussed in Section 4.

3.1. Hawaiian Electric's Capacity Planning Criteria

Hawaiian Electric's capacity planning criteria consist of one rule and one reliability guideline. The reserve capacity shortfalls calculated herein are determined by the application of the reliability guideline based on various key inputs such as the EFORds of each generating unit, the load to be served, the amount of capacity on the system, and the availability of the generating units.

3.1.1. Hawaiian Electric's Capacity Planning Rule

Rule 1:

The total capability of the system must at all times be equal to or greater than the summation of the following:

a. the capacity needed to serve the estimated system peak load, less the total amount of interruptible loads;

b. the capacity of the unit scheduled for maintenance; and

c. the capacity that would be lost by the forced outage of the largest unit in service.

Reserve Margin:

Consideration will be given to maintaining a reserve margin of approximately 20 percent based on Net Top Load Ratings.

Rule 1 includes load reduction benefits from interruptible load customers. Because Hawaiian Electric will not build reserve capacity to serve interruptible loads, interruptible load programs such as Hawaiian Electric's current Rider I and load management programs can have the effect of deferring the need for additional firm capacity generation.

3.1.2. Hawaiian Electric's Reliability Guideline: Loss of Load Probability

The application of Hawaiian Electric's generating system reliability guideline does take into account the Loss of Load Probability ("LOLP") that generating units could be unexpectedly lost from service.

Reliability Guideline:

> *Capacity planning analysis will include a calculation of risk (Loss of Load Probability) in years per day for each year of each plan of the long-range expansion study. In cases where risk is calculated to be less than 4.5 years per day, the plan will be reviewed by the Vice President of Power Supply, Senior Vice President of Operations, and the President for approval of use of the plan in the study.*

In order to determine whether there is enough capacity on the system to account for the probability that multiple units may be unexpectedly lost from service, the result of an LOLP calculation must be compared against Hawaiian Electric's generating system reliability guideline.

Hawaiian Electric has a reliability guideline threshold of 4.5 years per day. This means there should be enough generating capacity on the system such that the expectation of not being able to satisfy demand due to insufficient generation occurs no more than once every 4.5 years. Values less than 4.5 years per day indicate lower levels of reliability and an increased likelihood of generation-related customer outages.

One potential means to address the planning uncertainty and complexity would be to revise the capacity planning guideline. If the existing LOLP of 4.5 years per day does not provide an adequate cushion to respond to quickly-changing parameters, such as changes in peak demand and individual unit availability factors, many of which may change rapidly from year to year, then the utility could plan for a higher reliability standard similar to that of many mainland utilities. Such an approach would not eliminate quickly-changing parameters, but it would add a measure of conservatism in recognition that the uncertainties undoubtedly exist.

In its direct testimony for the Campbell Industrial Park ("CIP") Generating Station and Transmission Additions Project (Docket No. 05-0145), filed on August 17, 2006, the Consumer Advocate stated:

> [Hawaiian Electric's reliability guideline] is less stringent than the guidelines used by mainland utilities. As will be addressed later in my testimony, this guideline should be re-evaluated to determine if it should be more stringent in the future (e.g., one day in 6 years) to ensure reliable service. However, this determination should be based on analyses that assess the tradeoff between electric service costs to the consumer and the increase in reliability to be gained. CA-T-1 at 32.

The typical reliability standard on the mainland is 10 years per day, which is more stringent than the 6 years per day suggested by the Consumer Advocate and the 4.5 years per day in Hawaiian Electric's reliability guideline. A scenario analysis of the reserve capacity shortfall based on a higher reliability guideline threshold of 10 years per day is included in Section 5. The results of the analysis show the additional amount of firm capacity that would be needed on the O'ahu grid to meet a higher, 10 years per day, reliability standard based on the assumptions provided herein.

Please refer to Appendix 3 of the 2005 AOS report for additional information related to Hawaiian Electric's reliability guideline.

3.2. Other Considerations in Determining the Timing of Unit Additions

The need for new generation is not based solely on the application of the criteria previously mentioned. As capacity needs become imminent, it is essential that Hawaiian Electric broaden its consideration to ensure timely installation of generation capacity necessary to meet its customers' energy needs.

Other near-term considerations may include:

1. the current condition and rated capacity of existing units;
2. required power purchase obligations and contract terminations;
3. the uncertainties surrounding non-utility generation resources;
4. transmission system considerations;
5. meeting environmental compliance standards; and
6. system stability considerations for Hawaiian Electric's isolated electrical system.

In the application of Hawaiian Electric's capacity planning criteria that are used to determine its adequacy of supply, the inputs drive the results. Two of the key inputs in the application of the capacity planning criteria are (1) projected peak demand (including the anticipated peak reduction benefits of energy efficiency programs) and (2) the total firm capacity on the system. These key inputs are described in the following sections.

4. Key Inputs to the 2020 AOS Analysis

4.1. Period Under Review

This AOS review covers the period 2020 to 2024.

4.2. June 2019 Sales and Peak Forecast

Hawaiian Electric developed a sales and peak ("S&P") forecast in June 2019 ("June 2019 S&P forecast"), which was subsequently approved by the Company for future planning purposes. Hawaiian Electric's AOS is based on the Company's June 2019 S&P forecast and other key assumptions.

Figure 1 below illustrates Hawaiian Electric's historical system peaks, and compares them to the forecasts used in the 2019 and 2020 AOS analyses. The analyses contained in the 2019 AOS report were based on Hawaiian Electric's June 2018 peak forecast.

Figure 1: Recorded Peaks and Future Year Projections

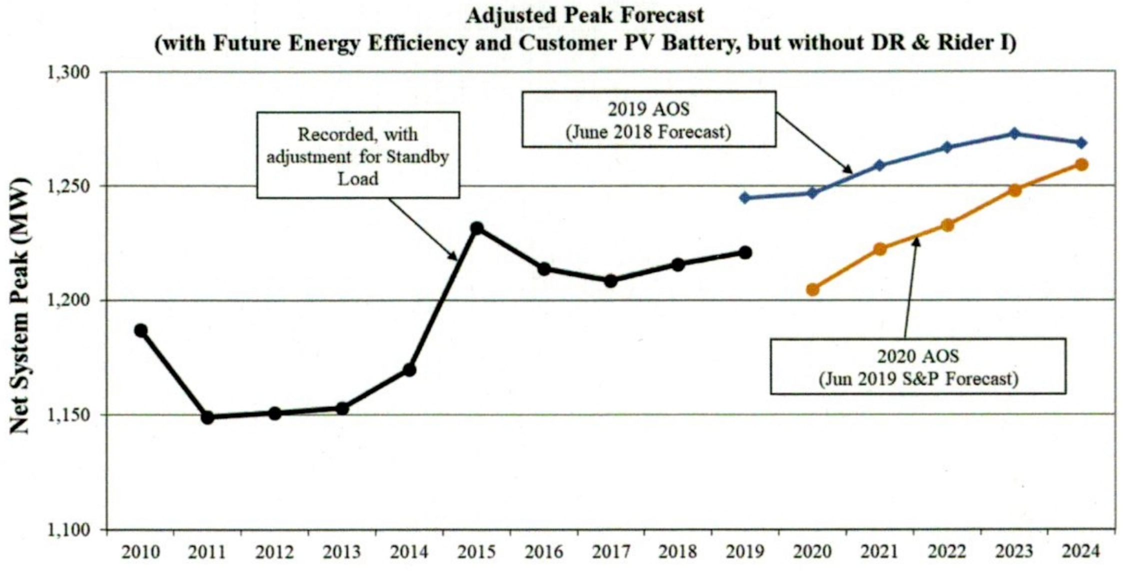

Table 1 below provides the recorded peaks from 2010 and the forecast used in the 2020 AOS analysis.

Table 1: Recorded Peaks and Future Year Projections

Net System Peak (MW) (with Future Energy Efficiency and Customer PV Battery, but without DR & Rider I)			
Year	Actual	Actual Adj for Standby Load	2020 AOS Jun 2019 S&P Forecast
2010	1,162	1,187	
2011	1,141	1,149	
2012	1,141	1,151	
2013	1,144	1,153	
2014	1,165	1,170	
2015	1,206	1,232	
2016	1,192	1,214	
2017	1,184	1,209	
2018	1,190	1,216	
2019	1,193	1,221	
2020			1,205
2021			1,222
2022			1,233
2023			1,248
2024			1,259

For both the recorded and forecast data (from the June 2019 S&P Forecast), figures reflect an upward (standby) adjustment to account for the potential need to serve certain large customer loads (i.e., Par Hawaii, Sheraton and Pearl Harbor) that are frequently served by their own internal generation. Figure 1 also includes estimated peak reduction benefits of energy efficiency programs and naturally occurring conservation. With the advent of storage technology (i.e., battery energy storage systems ("BESS")) for the consumer market, impacts of customer-sited PV paired with batteries were included in the peak forecast. As solar capacity continues to grow year over year, daytime loads are projected to be reduced and, all else being equal, the average daily load profile is expected to have a more pronounced difference between daytime and evening peak. With an operating assumption of BESS charging during the daytime hours, coincident with PV generation, and discharging the stored energy during the system priority peak period, the system peak has been reduced for this type of energy storage operation.

4.3. Projected Peak Reduction Benefits of Demand Response Programs

Hawaiian Electric is committed to pursuing demand response ("DR") programs designed to provide cost-effective resource options as identified in the Integrated Demand Response Portfolio Plan.[3]

In 2015, the Hawaiian Electric Companies[4] submitted to the Commission for approval a DR Portfolio Application in Docket 2015-0412. A Revised DR Portfolio was filed on February 10, 2017, which provided modified approval requests and DR program design, and targets (MW) consistent with the DR Portfolio used in the Power Supply Improvement Plan Update Report filing on December 23, 2016. On January 25, 2018, the Commission issued Decision and Order No. 35238, approving the Companies Revised DR Portfolio tariff structure framework.

On August 22, 2019, the Hawaiian Electric Companies issued Request for Proposal No. 103119-02 "Grid Services from Customer-sited Distributed Energy Resources". Final selections were made on January 9, 2020 where aggregators were selected that would offer grid services to the islands. For the purposes of this analysis, Hawaiian Electric's adequacy of supply was calculated using estimated DR impacts from Table 2, below.

Table 2: DR Impacts for Capacity Planning Purposes (MW)

Year	DR Total	Rider I	Total
2020	17.7	4.3	22.0
2021	44.1	4.3	48.4
2022	69.3	4.3	73.6
2023	93.9	4.3	98.2
2024	109.8	4.3	114.1

4.4. Hawaiian Electric Generating Unit Forced Outages

Forced outages and deratings reduce generating unit availability and are accounted for in the EFORd statistic. EFORd, a measure of forced outages and operations in derated conditions, is a subcomponent of generating unit availability – and a key driver in the capacity planning criteria and reserve capacity shortfall calculations. Lower generating unit availability and higher EFORd both contribute to an increase in reserve capacity shortfalls. The definition of EFORd and an example of the application of the EFORd formula is provided in Appendix 2.

[3] Refer to Docket No. 2007-0341.

[4] "Hawaiian Electric Companies" or "Companies" refers collectively to Hawaiian Electric Company, Inc., Maui Electric Company Limited , and Hawai'i Electric Light Company, Inc.

Outages for planned work and maintenance will continue to be more frequent and longer in duration than in previous years. Scheduling maintenance will continue to be a challenge for the existing units. As the generating units age,[5] they need to be maintained more often and for longer periods of time. In addition, in response to the changing resources on the system, such as variable generation resources, the generating units are being operated in ways for which they were not designed. Such operation increases the likelihood of unscheduled (forced) outages and operations at derated power levels. Generating units that are shut down unexpectedly generally require immediate maintenance. As resources shift to make the emergency repairs, maintenance outage schedules slip, making maintenance scheduling flexibility difficult. In addition, generating units operating in a derated capacity are generally operated for long periods in a derated state as scheduling a maintenance shutdown to restore the units to full power operations may take a long time.

Table 3 below provides the forward looking Hawaiian Electric EFORd data by unit. The forward looking EFORd values utilized in the 2020 AOS analysis are forecasted EFORd expectations for planning purposes based on a combination of historical data, experience, and operational judgment. The EFORd assumption generally reflects the four-year average of the specific unit, or group of similar units. EFORd projections are not certain, however, and actual experience may differ from the projections. It is difficult to forecast EFORd due to unforeseen conditions of aging units, longer planned maintenance schedules, and the operating stress placed on the units. Refer to Appendix 3 for specific generating unit information on EFORd.

[5] Hawaiian Electric's generating units (not including the Campbell Industrial Park combustion turbine installed in 2009 and the generating units at the Schofield Generating Station installed in 2018) are between 39 and 73 years old. Firm capacity independent power producer ("IPP") units are between 28 and 30 years old excluding Airport DSG.

Table 3: Forward-looking EFORd

AOS EFORd Rates	
	2020 Forward Looking
Waiau 3	18.7%
Waiau 4	16.1%
Waiau 5	19.3%
Waiau 6	7.6%
Waiau 7	8.3%
Waiau 8	8.3%
Waiau 9	8.2%
Waiau 10	8.2%
Kahe 1	8.3%
Kahe 2	8.3%
Kahe 3	8.3%
Kahe 4	8.3%
Kahe 5	6.6%
Kahe 6	6.6%
CIP CT-1	4.4%
Schofield 1	2.0%
Schofield 2	2.0%
Schofield 3	2.0%
Schofield 4	2.0%
Schofield 5	2.0%
Schofield 6	2.0%
HECO	**8.1%**

4.5. Planned Maintenance Schedules for the Generating Units on the System

Planned outages and maintenance outages reduce generating unit availabilities. The schedules for planned overhaul and maintenance outages change frequently due to unforeseeable findings during outage inspections or to changes in priorities due to unforeseeable problems. When major revisions to planned and/or maintenance outages occur, the Planned Maintenance Schedule is revised. The uncertainty of future maintenance schedules contributes to future planning uncertainty and may influence the magnitude of reserve capacity surplus or shortfalls.

4.6. Other Inputs

For the purposes of the analysis, Distributed Generation ("DG")-PV additions and DR impacts were included. No future firm or variable resource additions were included so that capacity needs could be examined without the addition of future resources. Any future resources to be acquired could contribute to meeting the needs.

4.7. Additions of Capacity

4.7.1. Firm Capacity Additions

No new firm capacity additions are anticipated from 2020 to 2024.

4.7.2. Non-Firm Additions

In addition to firm generation power projects, Hawaiian Electric purchases energy on an as-available basis from fourteen producers and anticipates adding additional variable generation renewable energy projects to the Hawaiian Electric system in the near future as these facilities achieve commercial operation.

Several variable renewable generation projects have been approved by the Commission or are pending review by the Commission. These are Na Pua Makani Power Partners, LLC (Docket No. 2013-0423), Aloha Solar II (FIT Tier 3), Mauka FIT One (FIT Tier 3), Ho'ohana Solar 1 (Docket No. 2018-0431, Mililani 1 Solar, LLC (Docket No. 2018-0434), Waiawa Solar Power LLC (Docket No. 2018-0435), and AES West Oahu (Docket No. 2019-0050). These variable renewable projects were not assumed in the calculation of reserve margin.

4.8. Reductions of Firm Generating Capacity

4.8.1. Honolulu Units 8 and 9 Deactivation

Honolulu Units 8 and 9 (with a combined rating of 107.3 MW-net) were deactivated on January 31, 2014. The 2020 AOS reference scenario reflects the Honolulu generating units remaining deactivated, and their capacities are not included in the analysis.

4.8.3. Capacity from AES Hawaii, Inc.

The existing Power Purchase Agreement ("PPA") with AES expires on September 1, 2022. For the purposes of the 2020 AOS analysis, it is assumed that the capacity from AES is 180 MW through the end of the contract term.

4.9. Capacity from Kalaeloa Partners, L.P., Combined Cycle Unit

The existing PPA with KPLP expired on May 23, 2016. The PPA, as amended, automatically extends on a month-to-month basis until either party notifies the other in writing that the negotiations have terminated. On October 30, 2019, Hawaiian Electric and Kalaeloa entered into an agreement that neither party will give written notice of termination of the PPA prior to July 31, 2020.

For the purposes of the 2020 AOS analysis, it is assumed that the 208 MW of capacity provided by KPLP stays available for the duration of the analysis period.

5. Scenario Analysis

5.1. Description of Scenarios

In energy planning, uncertainty is an important aspect. Therefore, a range of forecasts was considered in the analysis. Descriptions of the various planning scenarios are provided below:

- Reference Scenario
- Higher load forecast (60 MW increase in peak load)
- Revised system reliability guideline – Increased stringency of Hawaiian Electric's generating system reliability guideline from 4.5 years per day to 10 years per day

A scenario using a lower load forecast was not performed in the analysis. However, should lower loads occur in the future, it may provide more certainty regarding decisions to deactivate or decommission existing generation units.

A reference scenario consisting of assumptions such as Honolulu Units 8 and 9 remaining deactivated and are not counted towards capacity, no other unit deactivations, and KPLP remaining in service serves as the resource plan to which the following scenarios can be compared.

5.1.1. Higher Load Forecast

The Higher Load Scenario uses the assumption that the system peaks are higher by 60 MW. Such a scenario is possible if energy usage is higher than projected due to hotter or more humid than average weather conditions, lower than anticipated adoption of energy efficient measures and practices and/or an upswing in the economy as compared to the forecast occurs in the future. A 60 MW higher peak load is roughly equivalent to one standard deviation over a 20-year period of historical peaks. Table 4 summarizes the Higher Load Scenario peak requirements.

Table 4: Higher Load Scenario

Year	2020 AOS Jun 2019 S&P Forecast (MW)	60 MW higher Jun 2019 S&P Forecast (MW)	Difference (MW)
2020	1,205	1,265	60
2021	1,222	1,282	60
2022	1,233	1,293	60
2023	1,248	1,308	60
2024	1,259	1,319	60

5.1.2. Revised System Reliability Guideline

Another potential means to address the ever-increasing planning uncertainty and complexity is to revise the capacity planning guideline. As explained in Section 3.1.2, Hawaiian Electric currently uses a reliability guideline threshold of 4.5 years per day. If the existing LOLP of 4.5 years per day does not provide an adequate cushion to respond to quickly-changing parameters, such as changes in peak demand and individual unit availability factors, many of which may change rapidly from year to year, then the utility could plan for a higher reliability standard similar to that of many mainland utilities. Such an approach would not eliminate quickly-changing parameters, but it would add a measure of conservatism in recognition that the uncertainties undoubtedly exist.

Hawaiian Electric performed a high-level evaluation using a more stringent reliability guideline of 10 years per day. The purpose of this analysis was to determine the amount of firm capacity that would be required to meet this higher reliability guideline. The results of this high-level evaluation are shown in Section 5.2.

5.2. Results of Analysis

Table 5 below shows the capacity, in MW, in excess of the amount needed to satisfy Rule 1 of the capacity planning criteria. The analysis shows that Rule 1 is satisfied for the reference scenario for each year through 2024 under a reference set of assumptions including, but not limited to: (1) continued residential and commercial load management impacts at the levels described in Table 2; and (2) continued acquisition of third-party energy efficiency. However, as previously explained, Rule 1 results are deterministic and do not incorporate unit specific EFORd rates in their calculation.

Table 5: Rule 1 Analysis

Year	Rule 1 Results (MW)
2020	217
2021	262
2022	101
2023	124
2024	4

The LOLPs for the reference and planning scenarios were calculated using a production simulation model for each year.

Table 6 shows the results of the Generation System Reliability analysis. The system reliability in the scenarios shown varies depending on the firm generating units available, and the planned maintenance schedules.

Table 6: Generation System Reliability Guideline (years/day)

Generation System Reliability (years/day)			
Year	Reference Scenario	Higher Load (Add 60 MW)	10 yrs/day reliability scenario
2020	10.9	2.9	10.9
2021	34.3	8.7	34.3
2022	2.4	0.7	2.4
2023	1.4	0.4	1.4
2024	0.7	0.2	0.7

Table 7, below, shows the reserve capacity surpluses or shortfalls corresponding to the calculated reliability shown in Table 6. Reserve capacity shortfall, shown as a negative number, is the approximate amount of additional firm capacity needed to restore the generating system LOLP to be greater than the 4.5 years per day reliability guideline. A positive number indicates the amount of capacity over and above that amount needed to satisfy the 4.5 years per day reliability guideline. For example, in the reference scenario for 2023, the number -60 would indicate that about 60 MW of firm generating capacity would have to be added, in order for the expectation of not being able to satisfy demand due to insufficient generation occurs no more than once every 4.5 years.

Table 7: Reserve Capacity Shortfall for reference and planning scenarios (MW)

Year	Reference Scenario	Alternate Scenario	
		Higher Load (Add 60 MW)	10 yrs/day reliability scenario
2020	30	-30	0
2021	80	20	50
2022	-30	-90	-70
2023	-60	-120	-100
2024	-90	-150	-120

(Note: Negative values indicate a shortfall of generating capacity; positive values indicate a surplus of generating capacity)

The forecasts and analysis for 2022 through 2024 indicate that there may be insufficient generation available for reasonable emergencies and reserve capacity.

The results indicated for the 2020-2024 timeframe are based on present day assumptions and will change as the Hawaiian Electric system transforms into the future. The capacity shortfalls identified in this period are influenced by a set of assumptions, including but not limited to: (1) continued implementation of third-party energy efficiency; (2) forward-looking maintenance schedules and unit availability that will change in the years ahead; and (3) the extent to which new generating capacity is added.

The analysis shows that the reserve capacity shortfall is sensitive to the load forecast. In the case of the Higher Load Scenario, a nominal 60 MW increase in the forecasted load resulted in a 60 MW reduction to projected reserve capacity. Expectations regarding future loads can change quickly, and Hawaiian Electric may not be able to respond quickly to increases in demand. This illustrates the importance of using scenario analysis as a planning tool.

Table 7 further projects that approximately 120 MW of firm capacity would have to be added to the Hawaiian Electric system to achieve a higher reliability guideline of 10 years per day. The approximate 20 to 30 MW difference between the 4.5 years per day reference scenario and the 10 years per day Scenario to achieve higher levels of reliability is a non-linear relationship between MW capacity added and improvement in LOLP.

6. Mitigation Measures for Near-Term Reserve Capacity Shortfall

As a result of projected reserve capacity shortfalls, Hawaiian Electric has considered a number of actions to minimize the risk of generation-related shortfalls. These include implementing expanded DR programs, refinement of maintenance schedules, issuing calls for conservation, and procurement of temporary generation.

6.1. Implement Demand Response Programs

Hawaiian Electric will implement its DR Portfolio plan in accordance with Docket No. 2015-0412, and as discussed in Section 4.3 above.

6.2. Refinement of Maintenance Schedule

Scheduling maintenance requires consideration of many different operational factors. Maintenance scheduling can be expected to be adjusted several times over the year due to changing operational factors. In the event of reserve capacity shortfalls, rearranging maintenance schedules should be considered as a mitigation measure.

6.3. Call for Conservation

Hawaiian Electric may request voluntary customer curtailment of demand during capacity reserve shortfall conditions.

6.4. Temporary Generation

In the event that severe or prolonged reserve capacity shortfalls are anticipated, temporary emergency DG could be installed.

7. Conclusions

Hawaiian Electric's reserve capacity may not be sufficient to meet the Company's generating system reliability guideline of 4.5 years per day from 2022 to 2024.

The scenario analysis indicates that depending on system conditions, Hawaiian Electric may experience anywhere from a 90 MW reserve capacity shortfall under the reference scenario to a 150 MW reserve capacity shortfall in the Higher Load Scenario in the timeframe analyzed. Hawaiian Electric may seek to mitigate future capacity needs by increasing DR programs, refining maintenance schedules, or acquiring additional firm capacity.

Hawaiian Electric will continue its portfolio approach to meet its obligation to serve, which includes increased renewable energy contributions, energy storage resources, and the pursuit of firm capacity and non-firm supply side options. Hawaiian Electric also recognizes that the environment for resource planning has increased in complexity and uncertainty.

Very truly yours,

Joseph P. Viola
Vice President
Regulatory Affairs

Attachments

c: Division of Consumer Advocacy (with Attachments)

Table A1:
Projected Reserve Margins for the Reference Case

Year	System Capability at Annual Peak Load (net MW) [A] (I)	System Peak (net MW) [B] (II)	Interruptible Load (net MW) [C] (III)	Reserve Margin (%) [A-(B-C)] / (B-C)
2019	1,744	1,216	17	45%
2020	1,744	1,205	22	47%
2021	1,744	1,222	48	49%
2022	1,744	1,233	74	50%
2023	1,564	1,248	98	36%
2024	1,564	1,259	114	37%

Notes:

I. System Capability includes:
- Hawaiian Electric units at total normal capability in 2019 was 1,279.7 MW-net.
- Airport DSG (8 MW).
- Firm PPAs with a combined net total of 465.5 MW in 2019 from KPLP (208 MW), AES Hawaii (180 MW), and H-POWER (68.5 MW).
- Honolulu Units 8 and 9 were deactivated in 2014 (-107.3 MW)
- KPLP assumed to continue in service after 2019.
- Schofield Generating Station ("SGS") (49.4 MW).
- Following the addition of the SGS project in 2018, CIP CT-1 switched its primary fuel to diesel. The unit rating for CIP CT-1 consuming diesel increased from 113 MW to 129 MW.

II. System Peaks
- The 2020-2024 annual forecasted system peaks are based on Hawaiian Electric's June 2019 S&P Forecast.
- The forecasted System Peaks for 2020-2024 include the estimated peak reduction benefits of third-party energy efficiency programs.
- The peak for 2020-2024 includes approximately 29 MW of stand-by load.
- The Hawaiian Electric annual forecasted system peak is expected to occur in the second half of the year.

III. Interruptible Load:
- Interruptible Load impacts are at the net-to-system level and are approximate impacts at the system peak.

Equivalent Demand Forced Outage Rate Definition and Formula

As defined in IEEE Std-762-2006,[6] Section 3.8:

Equivalent Demand Forced Outage Rate (EFORd): A measure of the probability that a generating unit will not be available due to forced outages or forced deratings when there is demand on the unit to generate.

EFORd is defined in the North American Electric Reliability Corporation Generating Availability Data System Data Reporting Instructions,[7] Appendix F as:

$$\text{EFORd} = \frac{[\text{FOHd} + (\text{EFDHd})]}{[\text{SH} + \text{FOHd}]} \times 100\%$$

where

FOHd = f x FOH

EFDHd = (EFDH – EFDHRS) if reserve shutdown events reported, or

= (fp x EFDH) if no reserve shutdown events reported – an approximation.

fp = (SH/AH)

$$f = \left(\frac{1}{r} + \frac{1}{T}\right) \Big/ \left(\frac{1}{r} + \frac{1}{T} + \frac{1}{D}\right)$$

r=Average Forced outage deration = (FOH) / (# of FO occurrences)

D=Average demand time = (SH) / (# of unit actual starts)

T=Average reserve shutdown time = (RSH) / (# of unit attempted starts)

An example of the application of the EFORd formula to Hawaiian Electric's Waiau 9 generating unit in 2012 is shown below:

	Service Hours	Reserve Shutdown Hours	Available Hours				Equivalent Forced Derated Hours	Forced Outage Hours	
Capacity	SH	RSH	AH	Actual Starts	Attempted Starts	Failed Starts	EFDH	FOH	FO Events
53	67	7002.14	7069	26	27	1	0.00	1,067.26	5

=1/ (1067/5)	=1/(7002/27)	=1/(67/26)		=0.021397 *1067	=67/7069	=0.009416* 0		=(22.84/(67+22.84)) *100	=(1067/(1067+67)) *100
1/r	1/T	1/D	f	fxFOH	fp	fp x EFDH	EFORd x MW	**EFORd**	**EFOR**
0.004685	0.003856	0.390625	0.021397	22.83591142	0.009416	0	1,353.87	**25.54**	**94.1**

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[6] http://www.nerc.com/docs/pc/gadstf/ieee762tf/762-2006.pdf

[7] http://www.nerc.com/page.php?cid=4|43|45

Hawaiian Electric Equivalent Demand Forced Outage Rate ("EFORd") Discussion

It is extremely difficult to predict unit-specific EFORd rates, solely based on historical data. Nonetheless, for planning purposes it is necessary to estimate forward-looking EFORd rates. This is accomplished using a blend of historical data, experience, judgment, issues affecting aging generation including operation outside of original design parameters, and resource constraints. The forwarded looking EFORd are based on the 4 year EFORd averages for unit types with some exceptions as noted below. The 4 year average is appropriate because the majority of the flexible operations (low load operation and higher ramp rates) started in 2016. The units forward looking EFORd are as follows:

<u>Kahe 1-4 and Waiau 7-8:</u> 8.3%

The above units are all "small" reheat units operating under the same mission profile. These aging units range from 48 to 57 years of age and operate with higher ramp rates, operate under the variable pressure/low load operation, and cycle or will cycle when necessary. 8.3% EFORd represents the average 4 year EFORd average for these units.

<u>Kahe 5-6:</u> 6.6%

The above "large" reheat units operate under the same mission profile. These aging units range from 39 to 46 years of age are base loaded, operate many hours near minimum, and operate with enhanced ramp rates. 6.6% EFORd represents the average 4 year EFORd average for these units.

<u>Waiau 3:</u> 18.7%

This 73 year old unit still starts over 100 times per year and operates as a "limited use" unit. The unit does not undergo normal overhauls or extensive maintenance. The 18.7% EFORd is based on the 4 year average EFORd for the unit. The unit is not averaged with other units because it is in materially different condition.

<u>Waiau 4:</u> 16.1%

This 70 year old unit still starts over 100 times per year and operates as a "limited use" unit. The unit does not undergo normal overhauls or extensive maintenance. The 16.1% EFORd is based on the 4 year average EFORd for the unit. The unit is not averaged with other units because it is in materially different condition.

<u>Waiau 5:</u> 19.3%

This 61 year old unit still starts over 200 times per year. The unit has chronic problems associated with an aging integrated steam chest. Its current forced outage rates are expected to remain the same. The 19.3% EFORd is based on the 4 year average EFORd for the unit. The unit is not averaged with other units because it is in materially different condition.

Waiau 6: 7.6%
This 59 year old unit still starts over 200 times per year. The 7.6% EFORd is based on the 4 year average EFORd for the unit. Waiau 6 was not averaged with the "like unit" (Waiau 5) because of the material condition described under Waiau 5 above.

Waiau 9-10: 8.2%
The above combusting turbines are 47 years old and experience hundreds of starts per year. 8.2% EFORd represents the average 4 year EFORd average for these units.

CIP CT-1: 4.4%
This 11 year old unit has been experienced over 300 starts per year. 4.4% EFORd represents the 4 year average EFORd. CT-1 is a unique unit type and therefore not averaged with other units.

SGS Units 1-6: 2.0%
SGS is a new generating station commissioned in June 2018. High reliability is expected especially as early commissioning issues have been addressed.